# REPORT OF THE SIXTH MEETING OF THE WORKING PARTY ON RICE BREEDING

Held at Penang, Malaya
5 - 11 December 1955

Food and Agriculture Organization of the United Nations
Rome, Italy February 1956

Beginning in January 1955, reports of FAO Meetings held as part of the Program of Work of the Agriculture Division are being issued in the present form.

Reports are numbered chronologically within each calendar year.

The following reports of earlier meetings in this series have been issued:

First Meeting of the Working Party on Rice Breeding, Rangoon, Burma, February 1950

Second Meeting of the Working Party on Rice Breeding, Bogor, Indonesia, April 1951

Third Meeting of the Working Party on Rice Breeding, Bandung, Indonesia, May 1952

Fourth Meeting of the Working Party on Rice Breeding, Bangkok, Thailand, September 1953

Fifth Meeting of the Working Party on Rice Breeding, Tokyo, Japan, October 1954

Meeting Report
No. 1955/25

# Report of the

# Sixth Meeting of the International Rice Commission's

# WORKING PARTY ON RICE BREEDING

# convened by the Food and Agriculture Organization

# of the United Nations

Held at

Penang, Federation of Malaya

5-11 December 1955

Agriculture Division
Food and Agriculture Organization of the United Nations
February, 1956 Rome, Italy

FAO/56/2/1148

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# INTRODUCTION

The Sixth Meeting of the Working Party on Rice Breeding convened by the Food and Agriculture Organization of the United Nations and held, by invitation of the Government of the Federation of Malaya, at Penang on 5-11 December 1955, was attended by 29 participants representing 15 Governments.

FAO/56/2/1148

## PARTICIPATION IN THE MEETING

Delegates, Members of Delegations and Observers from Member Countries:

Australia

T.R. Lawler, Agronomist, Experiment Farm, Yanco, New South Wales.

Burma

U Khin Maung, Economic Botanist, Agricultural Experiment Station, Hmawbi.

U Tun Tin, Economic Botanist (Upper Burma), Mandalay.

France

A. Angladette, Directeur du Centre Technique d'Agriculture Tropicale, 45 bis Avenue de la Belle Gabrielle, Nogent, Marne (Seine).

India

N. Parthasarathy, Director, Central Rice Research Institute, Cuttack-4, Orissa.

Indonesia

H. Siregar, Head, Rice Research Institute, Bogor.

Japan

Takano Matsuo, Professor, Faculty of Agriculture, Tokyo University, Tokyo.

Korea

Young Chue Chang, Head, Department of Agronomy, Central Agricultural Technical Institute, Suwon

Laos

Thao Phanh Ngaosyvathn, Director of Agriculture, Vientiane.

Netherlands

M.H. Brédhaag, Agricultural Attaché, Netherlands High Commissioner's Office, Djakarta, Indonesia.

Pakistan

A. Alim, Economic Botanist, Department of Agriculture, Dacca.

Philippines

J.P. Torres, Acting Assistant Director, Bureau of Plant Industry, Department of Agriculture and Natural Resources, Manila.

D.L. Umali, Research Associate Professor, College of Agriculture, University of the Philippines, Los Baños, Laguna.

Thailand

Sala Dasananda, Assistant Director, Rice Department, Bangkok.

Krui Punyasingh, Chief, Rice Breeding Division, Rice Department, Bangkok.

United Kingdom

L.N.H. Larter, Acting Chief Research Officer, Department of Agriculture, Kuala Lumpur, Federation of Malaya.

R.H. Forster, Agricultural Officer, Department of Agriculture, Keningau, North Borneo.

F.B. Brown, Acting Senior Botanist, Department of Agriculture, Kuala Lumpur, Federation of Malaya

J. Doré, Plant Physiologist, Department of Agriculture, Kuala Lumpur, Federation of Malaya.

A. Johnston, Acting Senior Plant Pathologist, Department of Agriculture, Kuala Lumpur, Federation of Malaya.

R.J.W.A. Lever, Acting Senior Entomologist, Department of Agriculture, Kuala Lumpur, Federation of Malaya.

R.G. Lockard, Plant Physiologist (Colombo Plan), Department of Agriculture, Kuala Lumpur, Federation of Malaya.

Van Thean Kee, Botanist, Department of Agriculture, Kuala Lumpur, Federation of Malaya.

I.J. Wyatt, Entomologist, Department of Agriculture, Kuala Lumpur, Federation of Malaya.

Chew Hong Jung, Botanist, Department of Agriculture, Federation of Malaya.

United States of America

H.M. Beachell, Research Agronomist, Rice Pasture Experiment Station, Beaumont, Texas.

Viet Nam

Truong Van Hieu, Chief, Rice Service, Saigon.

Observers from Organizations

Rockefeller Foundation

R. Bradfield, Regional Director of Agriculture in the Far East, C/o Rockefeller Foundation, W. 49th. St., New York City, 20 N.Y. USA

South Pacific Commission

T.R. Lawler, Agronomist, Experiment Farm, Yanco, New South Wales, Australia.

U.S. Operations Mission

R.I. Jackson, Cereal Breeder, C/o American Embassy, Djakarta, Indonesia.

G.K. Middleton, Rice Advisor, C/o American Embassy, Bangkok, Thailand.

Food and Agriculture Organization Staff:

K. Ramiah, Rice Breeding Specialist, Agriculture Division, Food and Agriculture Organization of the United Nations, Bangkok, Thailand.

Subash Majumdar, Statistician, Economics Division, Food and Agriculture Organization of the United Nations, Viale delle Terme di Caracalla, Rome, Italy.

Y.T. Mao, Genetic Stocks Officer, Agriculture Division, Food and Agriculture Organization of the United Nations, Viale delle Terme di Caracalla, Rome, Italy.

Officers of the Meeting:

L.N.H. Larter of the United Kingdom was unanimously elected Chairman of the Meeting, and K. Ramiah of the Food and Agriculture Organization served as Technical Secretary.

A Drafting Committee under the Chairmanship of L.N.H. Larter included J.P. Torres, Sala Dasananda and K. Ramiah.

Acknowledgments

The Working Party expressed its appreciation of the welcome extended to the participants at the Meeting by the Honorable the Resident Commissioner of Penang, Mr. R.P. Bingham, and the Honorable Che Mohd. Khir bin Johari, Assistant Minister for Economic Affairs, who read a message from the Honorable the Minister for Agriculture, Federation of Malaya, Encho Abdul Aziz bin Ishak. Appreciation was also expressed to the Government of the Federation of Malaya for the excellent arrangements made for the Meeting and for the demonstrations and exhibits on fertilizers and related agricultural activities in Malaya, as well as the cordial reception and hospitality extended to participants during the Meeting.

SUMMARY OF DISCUSSIONS

Reports from countries on progress in rice breeding in 1954

Papers outlining the progress in national rice breeding programmes during 1954 were submitted from France, Malaya, India, U.S.A., Japan, Thailand, The Philippines, Vietnam, Indonesia, Korea, The Netherlands (Surinam), Egypt and Pakistan. The reports and the discussions that followed clearly indicated that rapid progress is being made in many countries with respect to rice breeding and seed development.

In Malaya as a result of recent selection work four new varieties have been released for distribution during the year. The physiological aspects of rice breeding are receiving increased attention and special attention is being given to problems of photo-sensitivity and varietal reaction to physiological diseases.

In India further progress has been made in connection with breeding for resistance to blast, and three strains, two from Andhra and one from Madras, highly resistant to blast were released during the year. Two of the Chinese varieties that have been tested over wide areas have been found suitable in several states and seed distribution schemes have been undertaken with them. From the Central Rice Research Institute, Cuttack, one new strain has been released.

The coming into existence of the cooperative rice improvement programme in The Philippines has given considerable stimulus to rice breeding. Extensive field trials both with existing and imported varieties are in progress in different parts of the Republic. Seed multiplication projects developed with purified strains of old standard varieties have made progress, and during the year over 225 tons of registered seed were distributed.

Rice breeding in Egypt has been directed towards obtaining (1) varieties with improved efficiency in water consumption, (2) varieties that can stand delayed transplanting and can withstand water shortage, and (3) varieties with grain of a higher commercial value. New varieties with these attributes may become available next year.

In U.S.A. long-grained types have rapidly replaced the old broad-grained varieties particularly in the South, and special attention is being paid to breeding varieties with improved cooking quality.

In Thailand the variety trials have been extended to 125 centres. The improvement work began with over 114,000 single plant selections which have now been reduced to 4,000 on the basis of observation and small scale trials. For the first time 300 farmers in the central and northern regions participated in growing pure seed of recommended varieties.

In Indonesia two new varieties of hybrid origin which have successfully passed through varietal trials have been released for distribution during the year. These new varieties, Sigadis and Remadja, are proving somewhat better in yield than the established premier variety Bengawan and possess additional desirable features including strong straw, earlier maturation and resistance to stem-borer.

In Pakistan it has been found that pure japonicas could be grown successfully during the spring season and under heavy fertilizer application. The japonicas yielded even better than local varieties. One interesting feature of this exploratory trial was that the japonicas gave higher responses to fertilization than the indicas.

The FAO International Hybridization Project

The project was undertaken at the request of the Working Party on Rice Breeding at its meeting in Rangoon in 1950, with a view to combining the adaptation to tropical condition of the indica rices with the characteristic high fertilizer response, and other desirable agronomic characters of the japonica group of rices.

The delegate from India presented a review of progress made during the year 1954/55 in the execution of the centralised aspects of the project at the Central Rice Research Institute, Cuttack, where, under the technical supervision of the Director of that station, the initial hybridization is performed.

The project, initiated in August 1950, for a period of three years, was later extended up to March 1956 on the recommendation of the Working Party. The objectives of the extended programme were:

1. To complete the original crossing programme and to extend it to include crosses of 63 further indica types received from some of the participating countries: Burma, Indonesia, Indochina, Malaya, Pakistan, The Philippines and Thailand, with two new japonica types, Zuiho and Fukoku, recommended by Dr. Morinaga of Japan as giving higher proportions of fertile hybrids in crosses with indicas than the previous japonica types;

2. to make back-crosses of the most sterile hybrids to the indica parents;

3. to undertake cytological investigations of the causes of sterility in the hybrids and to obtain further information on the origin of the genus Oryza.

Under the original programme 39 indica varieties from the participating countries were crossed with 8 japonica types. The cross combinations were completed and the $F_1$ seeds distributed to all the participating countries for growing $F_2$'s and subsequent generations. Under the extended programme 63 indica varieties were crossed with two new japonica varieties, and the crossing programme was completed during the year 1954/55. Seeds of 64 crosses which were completed during 1953/54 were distributed, and the $F_1$'s of the remaining 60 crosses are now in the field. The seeds of these will be sent to the respective countries early in 1956. During the period under review 6,050 $F_1$ plants were examined.

This was the first year of study of the cross combinations involving Zuiho and Fukoku, the two new *japonica* varieties reported to give consistently higher proportions of fertile hybrids in crosses with *indica* varieties than the *japonicas* previously used. Information on sterility in hybrids involving the new *japonica* parents is given in the table below. The *indica* parents used in the old and the new crossing programme were not the same, but it can be seen that there is practically no difference between the old and the new combinations in respect of sterility.

| Frequency distribution for sterility (percentage) | No. of hybrids (cross combinations) | |
|---|---|---|
| | Old cross combinations | New cross combinations |
| 0 - 10 | - | - |
| 11 - 20 | 1 | 1 |
| 21 - 30 | 11 | 3 |
| 31 - 40 | 24 | 4 |
| 41 - 50 | 46 | 3 |
| 0 - 50 1/ | 82 = 21.4% | 11 = 13.2% |
| 51 - 60 | 57 | 6 |
| 61 - 70 | 74 | 13 |
| 71 - 80 | 81 | 12 |
| 81 - 90 | 57 | 15 |
| 91 -100 | 32 | 11 |
| 51 -100 1/ | 301 = 78.6% | 57 = 86.8% |
| Total | 383 | 68 |

1/ For comparison of sterility between old and new cross combinations

Seeds of the $F_1$ generation of the various combinations, and of the second back crosses (the $BC_2$ generation) were also distributed to participating countries. The seeds intended for Indochina were sent to both Vietnam and Cambodia and the seeds for Pakistan were sent to both East and West Pakistan. In 1954, the Government of Australia joined the hybridization project and the territory of New Guinea was supplied with $F_2$, $F_3$ and $F_4$ seeds of several selected combinations.

It was also brought out that the segregates for sterility in $F_4$ formed three groups according to the cross combinations they came from. The data indicated that the inheritance of sterility was quantitative.

In 1954 a preliminary report was presented on the cytological studies of the causes of sterility and this year a full report was presented to the meeting on the work done up to October 1955.

In the study of spikelet sterility it was found that sterility in some cross combinations could not be entirely explained on the basis of gametic sterility. A certain amount of sterility was due to embroys failing to develop after fertilization. To some extent the spikelet sterility appeared to be governed by environmental conditions. Experience in Malaya and Indonesia, brought to the notice of the Working Party, indicated that the

degree of sterility depended partially on environmental factors. There was considerable difference in sterility in the same progenies grown in north and south Malaya, fertility being considerably higher in the north. In Indonesia the spikelet sterility of hybrids was more marked when they were grown in north Sumatra than when grown in Java.

Cytological irregularities during the reduction division could not wholly account for the large amount of sterility present in the $F_1$ hybrids. When cytological preparations of the tetraploids derived from pure indica and japonica types were compared with those from the indica x japonica hybrids practically no difference was found in the mean number of quadrivalents formed. Since the pairing behaviour was not largely affected it was inferred that such structural differences as there are between indica and japonica relate to very small segments of chromosomes.

In the study of the photoperiod response of the japonica x indica hybrids as compared with the japonica and indica parents, it was thought that chromosomal structural differences between indica and japonica might account for the difference in the photoperiod response. This was inferred from the fact that in O. officinalis, a photosensitive variety, a variant was isolated which was found to be non-sensitive, and a cytological examination showed that structural changes had occurred. This relation between structural difference and photo-period response suggests a possible method of evolution of the japonica varieties from the tropical indica ancestors.

From observations on the amount of sterility in the hybrids of reciprocal crosses it appears that the cytoplasm also contributes to sterility in certain cases.

Fourteen of the 23 listed species in the genus Oryza have been brought together at the Rice Research Institute. The classification of these species is being attempted from a study of the data on morphology and anatomy and also from some interspecific hybrids made for the purpose.

Special reports were presented on the behaviour of the crosses and the progress that has been made in obtaining useful progenies by selection. These reports came from India, Malaya, Thailand, Pakistan, Indonesia, Burma, and Vietnam and there was a full discussion of the results obtained. It was reported at the 1954 meeting that in the $F_3$ generation of many crosses selections had been obtained at Cuttack which yielded twice as much as the respective indica parents. It was stated that the 1954 results at Cuttack were confirmed in the $F_4$ generation and that similar encouraging results had been reported from two other States of India, Hyderabad and West Bengal, where the material was grown.

As compared to last year there was more optimism in many countries about the usefulness of the indica x japonica hybrid material. It was reported by delegates from Malaya, Thailand, Pakistan, Burma and Vietnam that the behaviour of the progenies was improving with successive generations, and were of distinct promise in their regions. In Java the material had proved disappointing, and also in Sumatra although part of the material had been grown at a higher elevation in an attempt to improve results. It was

mentioned that in the Philippines the progenies were being tested under both upland and lowland conditions and while some progenies were doing well under upland conditions their behaviour under lowland conditions has not been very satisfactory. In Thailand the material had been grown only in the north but during the year it had been tested at a station further south where the plants were found to grow very much better than they used to do in Bangkok. The delegate considered that the material was very promising. The report on the behaviour of $F_3$ progenies in East Pakistan was also encouraging.

One particular observation brought out in the discussion was that of the various japonica types used as parents, Taichung 65 and Pebifun, both from Taiwan, were giving consistantly a larger number of useful progenies in most countries, while the ability of other japonica parents to give satisfactory progenies varied from country to country. This was apparently due to the fact that these two varieties come from a tropical region. It was also considered that interested countries with the necessary facilities could themselves follow up this hybridization programme with greater confidence by increasing the number of indica parents in future hybridization programmes. Crosses between japonicas and some early maturing non-photosensitive varieties exhibit less sterility in the hybrids than crosses between japonicas and sensitive late maturing rices indicating again the possible advantages of intensifying the hybridization programme. In this connection the delegate from India kindly agreed that though the project would finish by April 1956 he would be glad to supply promising material from cross combinations other than those made for the respective countries. This could be very valuable as experience already available in Thailand and elsewhere indicates that cross combinations involving indica parents other than their own often prove better.

Many countries have adopted the recommendation made at previous meetings and have grown the segregating material in well fertilized fields. The delegate from India reported that no differential behaviour between progenies selected from the well fertilized and ordinarily fertilized fields was found. It was also mentioned that progenies selected from this hybrid material in Burma and Thailand included desirable types with round grain corresponding to the japonica type.

The Working Party was very satisfied with the progress already made in this project and wanted to record its high appreciation and thanks to the Government of India for the facilities provided at the Central Rice Research Institute at Cuttack. It also wished to record its thanks to the Director and Staff of the Institute. Although the FAO project is to finish by April, 1956, the Working Party recommended that member countries should continue to report to the Working Party the progress made in the project as part of their reports on national rice breeding programmes. The Director of the Central Rice Research Institute agreed to prepare a final report of the project after April 1956 and this will be considered at the next meeting of the Working Party.

While the full audited accounts are not available, according to the statement furnished by the Regional Office in Bangkok the total disbursements under the project for the period April 1954 to March 1955 were Rs.37,451. 12as. 3 pies.

## The Maintenance of Genetic Stocks of Rice

The recommendations made by the Working Party last year concerning the maintenance of genetic stocks at different centres had been given effect during the year and the Director of the Central Rice Research Institute, Cuttack, the Supervisor of the project, had obtained the necessary reports from the different centres and submitted to the Working Party a consolidated report for the year. Since his last report to the Working Party, the number of genetic stocks registered had increased from 862 to 1020 and the number of reporting countries from 30 to 32. A fifth supplement to the World Catalogue of Genetic Stocks has since been published by FAO showing a total of 1020 stocks. The registered stocks are listed as shown below:

| | Country | Stocks registered |
|---|---|---|
| 1. | Australia | 3 |
| 2. | Burma | 67 |
| 3. | Borneo | 3 |
| 4. | Cambodia | 26 |
| 5. | Ceylon | 21 |
| 6. | Costa Rica | 4 |
| 7. | Egypt | 9 |
| 8. | Fiji | 6 |
| 9. | France | 14 |
| 10. | Gambia | 1 |
| 11. | Guiana (British) | 3 |
| 12. | Honduras | 2 |
| 13. | Hong Kong | 6 |
| 14. | India | 300 |
| 15. | Indonesia | 40 |
| 16. | Italy | 11 |
| 17. | Japan | 213 |
| 18. | Madagascar | 19 |
| 19. | Malaya | 21 |
| 20. | Mauritius | 1 |
| 21. | Nyasaland | 1 |
| 22. | Pakistan | 59 |
| 23. | Peru | 9 |
| 24. | Portugal | 3 |
| 25. | Sierra Leone | 7 |
| 26. | Sudan (French) | 11 |
| 27. | Taiwan | 17 |
| 28. | Tanganyika | 4 |
| 29. | Thailand | 28 |
| 30. | Tchad | 34 |
| 31. | U.S.A. | 26 |
| 32. | Vietnam | 51 |
| | Total | 1020 |

These stocks are classified as:

| Non-floating indicas and bulus | Floating indicas | Japonicas | Others | Total |
|---|---|---|---|---|
| 718 | 24 | 268 | 10 | 1020 |

Out of these the following 22 stocks should be deleted:

G.S. Nos. 13, 18, 37, 39 and 65 from Burma,
G.S. Nos. 831, 832, 837, 838, 840, 842, 848, 852, 854, 855, 857, 859 and 861 from Tchad, and
G.S. No. 624 from France,

as they are no longer available from the registering countries. G.S. No. 75 from Ceylon is reported to be an erroneous insertion. G.S. Nos. 374 and 382 from Assam (India) are no longer available; however, these two are also registered from East Pakistan as G.S. Nos. 557 and 559, respectively. In addition to the 17 varieties registered as duplicates in the catalogue as was reported last year, one more such duplicate has also been found. The 18 varieties which are duplicated are given below:

| | | | | | |
|---|---|---|---|---|---|
| 1. | G.S. 403 | (Madras) | and G.S. 95 | (Gambia) |
| 2. | G.S. 350 | (Orissa) | and G.S. 358 | (Madras) |
| 3. | G.S. 458 | (Orissa) | and G.S. 457 | (Madras) |
| 4. | G.S. 429 | (Orissa) | and G.S. 758 | (Madras) |
| 5. | G.S. 377 | (Orissa) | and G.S. 378 | (Bihar) |
| 6. | G.S. 360 | (W.Bengal) | and G.S. 520 | (E. Pakistan) |
| 7. | G.S. 373 | (W.Bengal) | and G.S. 528 | (E. Pakistan) |
| 8. | G.S. 397 | (W.Bengal) | and G.S. 537 | (E. Pakistan) |
| 9. | G.S. 420 | (W.Bengal) | and G.S. 540 | (E. Pakistan) |
| 10. | G.S. 442 | (W.Bengal) | and G.S. 547 | (E. Pakistan) |
| 11. | G.S. 398 | (E.Punjab) | and G.S. 591 | (W. Pakistan) |
| 12. | G.S. 143 | (Malaya) | and G.S. 164 | (Borneo) |
| 13. | G.S. 142 | (Malaya) | and G.S. 1004 | (Taiwan) |
| 14. | G.S. 692 | (Sudan) | and G.S. 839 | (Tchad) |
| 15. | G.S. 696 | (Sudan) | and G.S. 858 | (Tchad) |
| 16. | G.S. 693 | (Sudan) | and G.S. 851 | (Tchad) |
| 17. | G.S. 697 | (Sudan) | and G.S. 860 | (Tchad) |
| 18. | G.S. 5 | (Honduras | and G.S. 170 | (Sierra Leone) |
| | 1 | (Br.Guiana) | | |

A few of the genetic stocks to be maintained at the different centres have not yet been received and the countries concerned are being requested to supply the seeds of these to the respective centres. It was pointed out that the duplicates mentioned in this report would be discarded.

During the discussion of this report it was pointed out that a few of the genetic stocks were found to be non-uniform and new seed of these would have to be obtained from the registering countries; also it was brought out that the variation could not have been due to environmental effect. Some non-uniform stocks have been included because they possess valuable characters and their lack of purity for some minor characters is unimportant.

The Supervisor of the project, however, mentioned that the method adopted for the maintenance of the material assured the retention of the particular characters for which the stock has been registered although its purity was not guaranteed. The delegate from the Philippines pointed out the difficulty of growing a large number of stocks every year and suggested that it may be possible to grow only a portion of the stocks each year. This would involve special facilities for storing seed under satisfactory conditions for retaining its viability. Such facilities for storage existed only in the U.S.A. In other countries the only way to deal with the problem at present would be to grow the material every year. The question of ideal storage conditions for maintaining seed stocks may be taken up at a future date.

The International Training Centre on Rice Breeding

The International Rice Commission at its fourth session held in Tokyo decided to hold the second Training Centre in 1955. This Training Centre, organised by the FAO in cooperation with the Government of India at the Central Rice Research Institute, Cuttack was held from 1st September to 30th November 1955, and attended by 20 trainees from 13 countries as shown below:

| | |
|---|---|
| Borneo | 1 |
| Burma | 1 |
| Ceylon | 1 |
| Egypt | 1 |
| Indonesia | 2 |
| Iran | 2 |
| India | 4 |
| Japan | 1 |
| Laos | 2 |
| Pakistan | 1 |
| The Philippines | 2 |
| Thailand | 1 |
| Vietnam | 1 |

The course of instruction included lectures on the principles of rice breeding supplemented by practical work in the field and laboratory, in the design of experiments and analysis of experimental data, and by tours in rice growing areas where the crop was studied under varying conditions of soil, rainfall and elevation.

The Working Party expressed its appreciation of the generous facilities made available by the Government of India, and of the keen interest and cooperation of Dr. N. Parthasarathy, Director of the Training Centre, and Dr. L. E. Kirk as Associate Director, and of all those who participated as instructors.

A special feature of this course was the holding of group discussions thrice a week on several aspects of cultivation, breeding and technology of rice. The trainees also had the benefit of lantern slide demonstrations of rice milling and processing techniques developed in U.S.A. which Mr. Beachell,

an instructor from U.S.A. had brought with him. Excepting the trainee from Vietnam who had to leave a month earlier due to illness, all the trainees maintained perfect health.

In considering the report, the Working Party emphasized the necessity for the participating countries to make full use of their personnel who attended the Training Centre by retaining them in rice improvement work. There was unanimity of opinion among the delegates as to the usefulness of these Centres and the Working Party accordingly recommended that FAO should organise another similar Centre at least in 1957. Without committing their Governments, the delegates were confident that at least 20 trainees from the participating countries would be prepared to attend such a Centre. Countries including France, Australia and U.S.A. who had not taken part in the previous training centres were convinced of the high value the countries would derive from this training, and the first two hoped to be able to send trainees in 1957. Opinions were expressed in favour of (1) holding the Training Centre in different countries, and (2) holding it in tropical regions. It was recalled that Japan had already agreed to organise the Centre in 1957. Some of the delegates would have preferred the Centre to be held in 1956 but it was pointed out that FAO could not possibly undertake this next year. In connection with the Training Centre many delegates considered that the lectures delivered should be more widely known and recommended that these lectures should be reproduced in mimiographed form and circulated to the member countries.

Resistance to Lodging

In accordance with the recommendation made at the 1954 meeting the coordinator of this cooperative project reviewed the progress that had been made since its inception in 1952.

The coordinated experiment designed at the 1953 meeting with a view to discovering correlations between plant characters and lodging had been completed by Vietnam and although the results have not yet been analysed statistically tentative conclusions were drawn. These indicated that no clear correlation was likely to be found but that contrary to expectations the taller varieties had lodged least. Vietnam proposed to continue with this experiment, and other countries including Thailand,, India and Pakistan expressed their intention of carrying out experimentation on the same or similar lines.

Papers were presented by Japan, Thailand and Malaya describing techniques aimed at measuring structural and mechanical characters likely to be related to lodging. Application of these techniques had in some cases (Japan) demonstrated close correlations between such characters and lodging in certain varieties or limited groups of varieties. The Japanese work has clearly shown that the factors controlling resistance to lodging are complex, as resistance may occur in varieties with both stiff and with pliable straw depending on other factors.

The general interest in this subject was apparent both from the discussion and from the number of papers on various aspects of the lodging problem which were presented. Work in India on the effect of lodging on yield is being continued and work is now in progress in other countries (The Philippines). Though the Philippines reported that with some varieties and under some irrigation conditions lodging and yield were unrelated, under other conditions and elsewhere the findings indicated that both the degree and time of lodging had a profound effect on yield. Lodging which occurred before and after flowering often reduced yield by 50 to 60 per cent (India, The Philippines, Pakistan). Other reports presented showed that wide spacing decreased lodging (The Philippines), that the effect on yield varied with variety (Malaya, The Philippines, et al) and that quantity and time of application of irrigation water (The Philippines) and the type and time of application of manure (Japan) produced significant effects on the amount of lodging.

From a review of the data which have accumulated over the past three years it is apparent that whereas in some cases satisfactory techniques for the evaluation of lodging resistance by measurement or estimation of varietal characters may be evolved, it is unlikely that such techniques will prove of general application. While lodging resistance is in some cases closely related to short straw, thick straw and high resistance to breakage, in many varieties or groups of varieties the opposite may be the case. The reason lies probably in the multiplicity of plant characters associated with lodging and the differences in their expression from variety to variety and from environment to environment.

The Working Party therefore recommended:

(i) that the attempt to determine a simple method of selection for lodging resistance of general application by coordinated experimentation should be discontinued, but

(ii) that in view of the growing interest in the subject, countries should continue and expand the investigations they have in progress, and

(iii) that those countries which have already commenced or propose to commence the coordinated experiment during the current season should do so and should forward the results to the coordinator as hitherto, and

(iv) that after the current season, the accumulated data should be reviewed periodically and a report included in the agenda of meeting of the Working Party from time to time for this purpose.

The U.K. Delegation offered to continue to provide a coordinator for this purpose and to prepare a review of the project from its inception for circulation to the countries represented on the Working Party.

Biological control of rice pests

The Working Party at its meeting in 1954 had recommended that FAO collect all available information on parasites of rice pests for consideration at its next meeting with a view to formulating a cooperative project if that were found suitable. The Malayan delegate in introducing the subject stated that pre-war experiments on biological control of the most important rice pest, the stem borer, had been abandoned. The main difficulty was the failure of the parasites to establish themselves in the field. The only successful instance of biological control of the padi stem borer is that reported from Hawaii, but the pest was an introduced one and therefore not comparable with the endemic pests occurring in the large tropical land masses. Attempts in Japan to establish various parasites imported from The Philippines and Java appear to have failed.

The delegate from India introduced a paper from the Central Rice Research Institute, Cuttack, containing an exhaustive list of rice pests and their parasites and the regions where they were found. Due to lack of facilities to breed the parasites under controlled conditions the work had not been taken up in India until now. It was agreed that the method of biological control had not been fully exploited and that there was considerable scope for research in this field particularly in relation to stem borers of rice. Though there was need for cooperation in all aspects of parasite work in South East Asia the Working Party felt, however, that it was better to await the establishment of the Biological Control Research Institute for Parasite Work in India, which was expected to be organized shortly. The delegate from India informed the Working Party that arrangements were being made at the Central Rice Research Institute for providing the necessary controlled humidity and temperature chambers for parasite work, and a senior officer was also being sent for training in Canada for this purpose. It was suggested that the various countries should, until such time as the Biological Control laboratory was established in India, collect information on the status of the parasites already existing in their own countries.

The Working Party recommended that all countries working on the biological control of rice pests should continue to do so actively and that all available information should be sent to FAO in Rome with a request that a consolidated report be prepared for consideration and necessary action at the next meeting. It was also recommended that when the Biological Control Institute is established in India it should give early attention to pests like rice stem borers which are of great economic importance in South East Asia.

Estimation of losses due to pests and diseases of rice

When the control of pests and diseases was under consideration at the Working Party meeting in 1954, it was understood that some countries had developed methods for estimating losses in individual fields although no attempt had been made to obtain a reliable estimate of losses for the whole country. The problem though important was considered a difficult one which needed further investigation. The estimation of losses due to insect pests and diseases has an important bearing on obtaining reliable information regarding crop production in every country. As a first measure the Working

Party recommended that all available information on methods of estimating losses due to pests and diseases of rice be assembled in a working paper for the consideration of the Working Party in 1955. The Working Party had for discussion a comprehensive paper from Japan, dealing with important rice pests and rice diseases. The Working Party had also two papers from India dealing respectively with pests and diseases and one from Malaya dealing with pests. The paper from Japan gave details on several methods which had been used to estimate crop losses caused by stem borers. It was found that the coefficient of loss varied widely from one locality to another due to differences in environmental conditions thereby indicating the difficulties involved in correct estimations. While the estimation of losses due to white ears, which usually follow the later broods of the insect, can be made with a fair amount of accuracy, the damage in the earlier stages of the plants growth is difficult to determine. A certain amount of work was also done on the distribution pattern of infestation and the method of sampling. It was felt that one of the important problems involved in getting a correct estimate of loss was the establishment of a convenient method of sampling applicable to the whole population.

In India preliminary exploratory experiments were done to assess the loss due to stem borer at the later growth stages of the plant. Regression equations were worked out and it was found that for every unit per cent increase in the white ear heads due to stem borer attack, the estimated loss in yield worked out approximately to 0.6%. Similarly, for gallfly, another important pest, the loss worked out at 0.5%. In this paper also the importance of sampling was emphasised in arriving at a correct estimate, and generally it was found that square samples of 2' x 2' taken at random in sufficient numbers to amount to at least 5% of the total area were suitable.

The question of estimating losses due to diseases was considered by the Working Party as of a less difficult nature in view of the availability of more efficient methods for control and for artificial infection. It was also possible in the case of disease to fix standards to help in scoring degrees of incidence. Nevertheless it was agreed that the techniques used in different countries needed coordination.

The Working Party felt that they were labouring under a handicap in dealing with subjects on pests and diseases without the assistance of competent entomologists and mycologists. The Working Party, therefore, recommended to FAO that it should arrange with the member countries to send mycologists and entomologists to the next meeting to discuss the whole problem in the light of submissions by Japan, India and Malaya and then decide on what cooperative action should be taken. This subject of estimation of losses, the Working Party felt, would need the help also of statisticians to formulate suitable methods of sampling.

Breeding for Blast resistance

The Working Party on Rice Breeding had recommended in 1954 that, in view of the importance of the control of blast disease in most rice growing countries, available information be collected by correspondence and embodied in a working paper for consideration in 1955. The delegate from India had been entrusted with this responsibility and accordingly, after collecting the necessary data from six countries, viz. Ceylon, Italy, Japan, Taiwan, U.S.A. and India he had prepared a comprehensive paper, which included procedures for undertaking cooperative work.

Information collected on methods of testing resistance is discussed under artificial infection, natural infection, standardisation of methods for securing disease incidence and criteria for deciding on resistance to blast. The working paper also provided information on the progress so far made in the production of resistant varieties. On the basis of this information suggestions regarding standard procedure were recommended for adoption as follows:

Artificial infection tests should be carried out on 20 - 40 day old seedlings inside a green house, including at least 25 - 50 seedlings of each variety or progeny under test. The seedling test is important in eliminating susceptible varieties or progenies at an early stage and is particularly valuable when dealing with a large number of segregating progenies. In field tests for adult plant resistance 100 plants should be the minimum unit. In such field tests a susceptible variety is always grown close to the varieties to be tested, and if necessary all of the varieties are sprayed with heavy spore suspensions. Once a variety appears to be resistant it should be tested in the field for a minimum period of two years. It is also desirable to test the varieties in as many localities as possible in each country.

The question of specialisation of the fungus will have to be first determined on the basis of the behaviour of the resistant variety in different localities. This problem should be further taken up only when the environmental conditions can be controlled. A comprehensive schedule for standard procedures regarding level of fertilization, temperature, inoculum and natural infection of the field was suggested for adoption.

In the discussion that followed in which several delegates took part, great stress was placed on the effect of environmental conditions on the incidence of the disease in rice. For example, a popular local variety like Mas is not attacked by blast when grown in Java, but the same variety is found to suffer very badly from blast when grown in north Sumatra, while the local varieties growing alongside, escape damage. A reverse position was cited in the example referred to by the delegate from Thailand where it has been found that the newly established varieties are more resistant to blast than the local varieties. Cases of introduced varieties suffering badly from blast were also mentioned by the delegate from U.S.A. He also referred to the possible existence and identification of three races of blast which were at present under investigation there. After further discussion the Working Party recommended that:

(i) in the four centres where genetic stocks are maintained (except Indonesia where the disease is not present) careful field observations should be undertaken to isolate resistant varieties;

(ii) that resistant varieties of different countries should be distributed to all the rice growing countries where blast is a problem with full descriptions of the conditions under which they were found to be free from the disease. The cooperative testing of these varieties will indicate the existence or otherwise of physiological specialisation;

(iii) that the Director, Central Rice Research Institute, Cuttack, be requested to accept the responsibility of corresponding with the countries concerned and prepare a list of the resistant varieties available in different countries.

The Working Party also recommended that the member countries should, wherever facilities exist, intensify their programme of hybridization with a view to breeding new resistant varieties.

The inheritance of yield components

Inheritance studies of yield components was considered a possible subject for adoption as a cooperative research project. (Its importance in relation to yield did warrant a coordinated attack.) The Working Party in 1954, recommended that a note be prepared summarising the present position with suggestions for the investigations that might be organised on a cooperative basis. Dr. T. Matsuo of Japan presented this note together with a review of work done on the inheritance of yield components in rice for the consideration of the Working Party.

The paper submitted by Dr. Matsuo was very comprehensive and covered the breeding procedures followed in Japan during recent years which concerned the various quantitative characters contributing to yield. These characters include plant type, weight of panicle, number of panicles, weight of kernel, number of kernels, length of panicle and plant height. The approach adopted in Japan was to divide the rice areas into ecological units and then decide upon the most important quantitative characters that are common for the varieties in each area. In classifying varieties the main point is to distinguish the **panicle** number type from the **panicle** weight type. In general, "panicle-number type" varieties yield well in fertile areas while the "panicle-weight type" varieties are adapted to poor soil areas and also to areas with lower temperatures. According to available experimental data most of the yield attributes mentioned earlier belong to polygenic systems, but, depending upon low or high correlations in earlier or later generations, a decision is taken as to which character should receive earlier attention than others. For example, in the earlier generations, i.e. in the $F_2$ and $F_3$ it would be more appropriate to select for culm length and panicle length while selection for panicle weight and panicle number could be delayed until a later generation. In a programme of selection for disease resistance and maturity period, selection at the earlier stages is more profitable. Knowledge of the heritability of the various factors affecting the yields of

rice under different environmental conditions will guide the breeder in adopting different selection methods.

The paper also deals with the comparative merits of the mass (bulk) and pedigree methods of breeding. Although the pedigree method is the one generally used in Japan it is stated that under certain conditions the bulk (mass) method might prove of value. This, however, needs confirmation through more detailed investigations.

In the discussion that followed it was realised that the paper contained valuable hints that could be adopted and tested in the breeding of indica varieties where at present there is little critical information on the inheritance of yield components. Although Dr. Matsuo's paper was intended to present proposals for undertaking cooperative studies on quantitative inheritance the discussion clearly showed that most places did not have at present proper facilities and personnel to undertake exhaustive work on the subject. The Working Party therefore suggested that such projects should form part of the work of research institutes where facilities might be available.

Another paper from Japan reviewed work done in all countries on the studies of inheritance of yield components in rice, and provided a valuable source of information on the subject.

The Linkage Groups in Rice

The Working Party at its 1954 meeting had recommended that a note on the subject be prepared for consideration and action at the Penang meeting. A short note submitted by Japan dealt with the addition of a few genes to linkage groups 1, 4 and 5 described by Dr. Jodon, a rice geneticist of the U.S.A., who has done much work on linkage. Dr. Jodon's data indicate the existence of 8 linkage groups out of the possible 12, and enumerated the genes of each group. Dr. Nagao of Japan has suggested four groups mainly from the data of Japanese workers (the working paper presented to the Working Party). Three of Nagao's groups correspond to Jodon's 1st, 4th and 5th groups, and Nagao has made additions to these groups. The 4th group of Nagao which has five recognised genes has no counterpart in Jodon's classification and may perhaps represent a 9th linkage group.

It was decided that the Working Party had insufficient information to warrant definite recommendations for cooperative action.

In this connection the Working Party also took notice of the present position of genic nomenclature in rice. While the nomenclature suggestions of Indian workers made several years ago are being adopted in India, U.S.A. and elsewhere, Japan is following a different system and a state of confusion has arisen. For linkage studies a standardised universally accepted genic nomenclature is a necessity. The Working Party desired that the systems used by Japanese workers and others should be merged as early as possible.

The Working Party realised that sufficient work on genetics and linkage, which are basic to plant breeding work, has not been done in Asian countries (Japan is perhaps an exception) in spite of the great importance of the crop to more than half the world's population. This situation is due to a lack of trained personnel and the necessary facilities in the region. The subject of genetics does not receive sufficient attention even in universities. The Working Party therefore recommended that Member Governments make provision for the intensification of studies on rice genetics and undertake to provide facilities and train personnel for the purpose. The Working Party is of the opinion that linkage studies as a cooperative project should be deferred for some time. It is hoped that the new rice institutes that are being established in some of the countries will strengthen programmes on genetical research.

The Working Party recommended that as a first step towards encouraging linkage studies FAO should organise a small committee and should invite Dr. Jodon of U.S.A., Dr. Nagao of Japan and Dr. Parthasarathy of India, with Dr. Jodon as the convenor to serve on this Committee. The objectives of the Committee would be to examine the present position of linkage studies in rice, resolve difficulties of nomenclature and prepare a report to be considered at the next meeting of the Working Party.

Cooperative variety trials

At the Rice Breeders Working Party meeting held in October 1954 in Tokyo, the possibility of undertaking cooperative variety trials was considered. It was realised that with the continuously accumulating information on successful introduction of varieties from one country to another there may be scope for such trials even in rice with a limited adaptability. It was suggested that such variety trials should be organised on a climatic regional basis. If the varieties for each regional trial were carefully selected useful information could be obtained particularly on regional adaptation and ecology of rice. The importance of ecological studies to ensure the most practical results from rice breeding, introduction and seed distribution programmes was emphasized. The Working Party recommended that a suitable scheme be prepared by the FAO Rice Liaison Officer for consideration at the meeting in Penang. The Liaison Officer presented such a scheme at this meeting and explained the basis of the selection of varieties for trial in different rice growing countries.

The main difficulty regarding introduction of varieties is the change in the maturity period arising out of photo-period response. Observations on the growth of introduced varieties in the different countries has given some idea of the extent of such changes in the maturity period. For instance, some varieties in India maturing in about 90 days took 120 days in Japan and about 160 to 170 days in Italy. However, the main basis of grouping in the present scheme is according to seasons, which includes photo-period. Temperature also to a limited extent has influence in altering the maturity period as can be seen by the growth of rices at high altitudes and on plains situated in the same latitude. Another advantage with regard to grouping according to seasons is that the maturation period is less affected by latitude than by the planting season.

There are generally two main growing seasons, south-west monsoon (May to October) and north-east monsoon (October to February), and the time of planting depends on the onset of the monsoon and on other conditions prevailing in each locality. Statements indicating the rice growing regions in different latitudes and suitable varieties for those latitudes were also presented. The names of selected varieties for the different maturity periods according to the different latitudes have also been indicated for both south-west monsoon and north-east monsoon seasons.

The discussion of this subject by the Working Party indicated that it may not be possible for the different countries to start cooperative trials immediately. However, each country could carry out in 1956 an exploratory trial of the selected varieties, and on the basis of the magnitude of changes in maturity periods and other agricultural characters the countries could select promising varieties and agree on a cooperative trial to start during the following season. All the countries expressed a desire to participate in this cooperative trial and some of the countries were interested in trying varieties in both the early and late groups and testing them in the two different seasons.

Before deciding on the form of cooperative trial to use, the advice of Dr. Mazumdar, FAO Statistician, was obtained to assist in the discussion on procedures and designs for the trials. Dr. Mazumdar said that similar cooperative trials in wheat in the Middle East have been organised by FAO and simple lattice designs were recommended for such trials because the number of varieties was large (about 60). Since the varieties will be grouped on the basis of their maturation periods, the number of varieties in each trial will be limited to not more than 20 to 24. The problem of design would therefore be simple and he expected that some common varieties would also be grown in the trials in the different countries so that country x variety interaction could be estimated. This would provide the necessary information on the reaction of varieties under different ecological conditions. There was a lengthy discussion on collecting supplementary information on the effect of using different plot sizes, fertilizers, spacings, etc., and it was generally agreed that it was not possible to insist on a common procedure. If these trials could be held in two or more places within each country such information could be obtained by individual countries. The statistician was of the opinion that though the plot size may vary from country to country according to the practical conditions prevailing it might, however, be possible to harvest a crop from a standard unit area so that the necessary statistical computations covering so large a series of data could be simplified.

It was finally agreed that during the first year (1956) the varieties should be grown in preliminary observation plots with at least two replications; that each country should select the most suitable varieties given in the list according to the prevailing agronomic conditions; and that the cooperative trials should be started during the succeeding year. With the information available it should be possible at the next Working Party meeting for the statistician to suggest suitable designs so that the maximum information possible could be obtained from these trials. The discussions also indicated that expeditious arrangements would have to be made in order to obtain the seeds for trial and distribute them to the different countries

in time for seeding in 1956. The Liaison Officer agreed to take the necessary steps through the Regional Office at Bangkok. It may be possible in some cases for countries to get in touch with each other directly and arrange for the seed supply. Where this is done the Liaison Officer should be kept informed of details of such arrangements. One pound of seed would be the maximum available to each country of any particular variety and countries desiring to expand trials in the following season should make their own arrangements for multiplication of seed stocks. The countries distributing the seed should see that the seeds sent are viable and are accompanied by phyto-sanitary certificates. It was also agreed that delegates from the respective countries should get in touch immediately with the Liaison Officer specifying their requirements.

Interaction between Varieties and Fertilizers Response

In the absence of the delegate from Ceylon, the coordinator for this project, the summary report on investigations conducted in Malaya, Burma, U.S.A. and Indonesia was presented by the Technical Secretary to the joint meeting of the Working Parties. Information relating to India received subsequently was presented at the meeting by the delegate from India.

Malaya. In Malaya 11 indigenous varieties were tested at two fertilizer levels of N and P in six centres. In all centres except one the response to fertilizers was striking. At two centres varieties responded differentially to fertilizers, and at one of these centres two varieties showed a conspicuous response while another did not benefit from fertilizer applications. Three japonicas from Taiwan tested in 1951 showed marked response to fertilizers, but the interaction between varieties and fertilizers was not significant. In the second series of trials, a pure line selection was tested against local varieties on manured and unmanured plots on 25 small holdings. Differences in varieties and in manuring were significant, but varieties showed no differential response to manuring.

Burma. A trial in Hmawbi which commenced in 1953 and continued for two seasons included 5 varieties and 3 fertilizer levels with N and P. While the main effects were significant, the variety-fertilizer interaction showed no significance. A trial in Mandalay with 20 varieties at three fertilizer levels of N and P also showed that the main effects were significant but the varieties did not interact significantly with fertilizers.

The United States of America. At Stuttgart, Arkansas 3 varieties were tested at three levels of N. Varieties and fertilizers showed significant effects and there was also a differential response of varieties to fertilizers.

At Beaumont, Texas the performance of two early maturing varieties was compared at four levels of N, two levels of P and two levels of K. Not only were main effects significant but the variety-fertilizer interaction assumed significance at the 1% point. While one variety had a striking fertilizer response, the fertilizer application actually depressed the grain yield of the other. Although the experiments did not indicate clearly the nutrient element to which the varieties responded differentially, other trials conducted on Beaumont clays suggest that the main response is to nitrogen.

Indonesia. A range of 20 varieties including early and late forms of indicas and bulus were compared at two levels of N and two levels of P. The effect of N was significant at 1% point but P produced no yield increase. There were strikingly significant differences between and within groups of varieties but the variety-fertilizer interaction did not reach significance. The analyses appeared to show that the replicates differed markedly in soil fertility.

The experiments confirm the view expressed in the coordinator's previous reports that marked differences in fertilizer response exist within the indica group.

Considerable difficulty is experienced in interpreting the results of experiments in which effects of N and P are not separable. The need for ensuring that different levels of N and P are combined factorially in such a manner that separate assessments of the individual effects of these elements may be made cannot be too strongly stressed. For various reasons investigators in most countries have manifested greater interest in the varietal response to nitrogen, and the term 'fertilizer response' has often been used synonymously with 'nitrogen response'. Since the initiation of this coordinated project, no country has reported any instance of a differential response of varieties to P. Recorded cases of varietal response to N, on the other hand, have not been uncommon even in the indica group. While the recent investigations of the Japanese workers have thrown considerable light on the nature of varietal response to N there is no comparable information on the nature of the response to P.

Many soils show a marked interaction between nitrogen and phosphate; there may be no response to nitrogen unless the phosphorus level is adequate. It is accordingly necessary, even in trials designed to evaluate variety-nitrogen interaction , to incorporate a satisfactory basal dressing of phosphorus and even of potash as well. Limiting factors should not be permitted to interfere with the expression of nitrogen response.

The interaction between varieties and the time of nitrogen application has been demonstrated both in Indonesia and U.S.A. The investigations reported from Malaya are also suggestive. The fact that early applications of nitrogen accentuate differences in fertilizer response should be noted in the design of experiments. Preferably time of nitrogen application should be combined factorially with varieties and nitrogen levels. If the inclusion of times of nitrogen application as a treatment is not possible, early application of nitrogen should be insisted on.

In an experiment at Cuttack, India, 65 varieties, grouped into three maturity classes, were tested at three levels of N and P. The variety-fertilizer interaction was evident only in the late maturity class while the yield in the early and medium maturity classes was depressed due to premature lodging.

A report of a trial in Thailand with six varieties and three levels of N and P at three centres was presented to the meeting. The data seemed to indicate variety-fertilizer interaction.

In a trial in which blocks differ markedly in fertility, the inclusion of varieties showing differential response to fertilizers would increase the within-block variance assignable to error, and might prevent the demonstration of significant variety-fertilizer interaction. It is suggested that in variety trials, blocks possessing, as far as possible, the same average fertility should be used. Moreover, the use of split-plot designs with fertiliser treatments occupying the main plots and varieties the sub-plots may be employed profitably. Such designs, although possessing fewer degrees of freedom for error than the simple randomized block designs with the same number of replicates, appear to provide greater precision in the testing of variety-fertilizer interactions.

In the discussion following the above-mentioned reports field plot technique came up for consideration and FAO Statistician, Dr. Mazumdar, explained that there were factorial designs in which the number of plots necessary for an experiment may be even smaller than the total number of treatment combinations. It would be possible to study numerous factors at various levels with a factorial approach. Many experimenters have found difficulty in combining varieties of different maturity periods. There may be statistical hazards in combining varieties of widely differing maturity periods and growth habits in a single experiment. For experiments of the kind under discussion the split plot design should be more useful, although he was not sure about the advantage of dealing with fertilizer treatments in the main plots and varieties in sub-plots. If there was differential reaction to fertilizers by different groups of varieties it should be possible to derive both inter-group and within group interactions. He said that it might be possible to extend the analysis of even the present data to bring out additional information. He drew attention to the necessity for the services of statisticians at experimental stations particularly in the earlier stages of designing layouts. Although there might be differences between the suggestions of the Statistician and the practicability of recommended layouts under field conditions, the difficulties could be overcome by considering all points before the experiment was actually started.

An opinion was expressed that emphasis should be changed from nitrogen to phosphorus because of the economic and agronomic advantages of providing phosphate to the plant at as early a stage of its growth as possible. In this connection the study of interaction between varieties and nursery manuring was recommended. Quantity of phosphorus to be used will depend on the nature of the soil concerned. Questions on time of fertilizer application and their effect on the strength of straw were also raised. Further discussions were held on whether the present trials should be continued on the existing lines or should be redesigned to obtain information on time of fertilizer application, variety-phosphate interaction, calculation of the regression function to secure a correct estimate of the fertilizer response unaffected by other variables, etc. On the last point the Statistician was of the opinion that such investigations might involve different trials. After further discussion the Working Parties recommended:

That Member Countries should continue cooperative investigations on variety-fertilizer interaction. It is further recommended that, where such an interaction has already been clearly demonstrated, consideration should be given to separating the effects of the different nutrient elements by suitable experiments and that the time of application of each of these nutrients should be studied in relation to its effect on this interaction. At a later stage in these investigations a study might be made of the gradient of the response curves of different varieties as suggested by the coordinator.

Physiological Diseases of Rice

As convenor of the cooperative project on physiological diseases of padi, Mr. A. Johnston (Malaya) reviewed progress during the past year and suggested lines for further investigations. He reported that work had been carried out in India, Pakistan and Malaya. In India, it was found that a disease somewhat similar to the penyakrit merah disease of Malaya was at a maximum when the oxygen requirement was high, and was associated with the presence of reduction products in the root zone. Application of phosphate and draining the fields reduced the severity of this disease; however, the effect of phosphate was not always consistant. In East Pakistan, it was noted that 'pansuk' disease was associated with stagnant water and partial recovery could be obtained by drainage and application of fertilizers. Both India and East Pakistan gave lists of varieties showing differing susceptibility to these diseases. In Malaya, work was in progress along the following lines: growth in sand culture, pot experiments with soil from areas in which the disease had occurred, field fertilizer trials, varietal resistance, water stagnation, and nematodes.

Further discussion of the convenor's report brought to light additional pertinent information. Some past work in Burma has shown that application of phosphates had alleviated the diseases myit-po and amyit-po even when applied after the diseases had appeared. Another physiological disease, 'yellowing', was cured by the application of sulphur or sulphates.

In North Borneo, the orange type of leaf symptom occurred in rain-fed areas and there is experimental evidence which suggests that the cause was Nephotettix attack. Similar symptoms had also been observed in Malaya, but there were many cases in which the disease symptoms appeared when Nephotettix was not present.

A survey of the literature indicates that the better growth of rice on submerged rather than on well drained soils is associated with the increase in the concentration of certain elements especially iron and manganese. There is also evidence that under certain conditions these products of reduction can accumulate until they reach concentrations which are toxic to the rice plant. In order to get a clearer picture of these relations, C.F. Ponnamperuna of Ceylon undertook the study of rice plants grown in pots in which a wide range of concentrations of iron and manganese were developed by subjecting the soil to the following treatments:

1. 3 different pH values;

2. 3 different organic matter levels; and

3. different water levels.

Symptoms which seemed to be similar to those described in the literature for 'mentek', 'penyakit merah' or 'browning disease' were produced by certain of the treatments. When the water drained from the pots was analysed, the amount of growth of the rice and the intensity of the physiological symptoms were found to be closely correlated with the concentration of the various products of reduction resulting from the various treatments. Ferrous and manganous ions were the predominating constituents in the drainage water, being present in concentrations of over 500 p.p.m. and 80 p.p.m. respectively at certain periods. The effect of the various treatments on the growth of the rice plants seemed to be associated primarily with the effect which they exerted upon the concentration of the products of reduction in spite of the fact that they differed widely in their nature and in their effect on other properties of the medium.

On the basis of these studies the proportion of the various products of reduction, many of which are probably toxic when present in sufficiently high concentrations, may be expected to vary with different soils and probably produce variations in the foliar symptoms. Similar studies on other soils, under different climatic conditions and with different varieties of rice would appear to be justified.

The results offer an explanation of the effectiveness of many of the diverse practical remedies which have been proposed from time to time, such as: midseason drainage, ridging the soil around the rice plant above the level of the water, growing rice in rotations involving upland crops, emphasis on drainage, etc. The greater prevalence of the 'disease' in low spots which receive drainage water from higher adjacent areas can also be explained.

If the indications described above prove upon further study to be widely applicable, it should be relatively simple to develop:

1. diagnostic techniques applicable under field conditions;

2. effective methods for preventing or reducing the effects of these physiological diseases which are so widespread in the rice growing areas throughout the world.

In the United States of America analyses of soils from submerged padi fields in which physiological diseases occurred have been made. There was usually a high iron content but more consistent was the manganese/iron ratio, this always being less than 1/10. There was some evidence to show that this ratio was more important than the total amount of either element. Some French workers have found that in areas of manganese toxicity the amount of manganese in the leaves was also abnormally high.

In Indonesia it has been found that the adventitious fibrous roots, which are affected by root rot, suffer from lack of oxygen and die, whereas the coarse roots have air spaces and do not suffer in this way. It would also appear that any agricultural practice which makes padi soils more permeable to oxygenated water is beneficial in preventing physiological disease. In Indonesia the good effect of phosphate is ascribed partly to the diminution of ferrous iron in the soil solution, partly to the stimulation of root formation and partly to the stimulation of algae growth.

In the Tanjong Karang district of Selangor, Malaya, soon after land was put under padi cultivation there were large amounts of iron and organic matter in the soil but grain yields were very high. On the other hand, in old established areas in Kedah, although iron has been leached down to the oxidation zone below the reducing zone, 'penyakit merah' sometimes occurs, suggesting that some factor other than excess of iron may be involved. However, the important factor probably is not the total amount of iron in the soil but the amount in solution and this changes quickly becoming high with water-logging.

In the United States of America straighthead, another physiological disease, occurs on sandy soil under continuous flooding. The trouble can be partly cured by draining at the critical period which probably corresponds with the time of panicle differentiation. A similar disease was reported from North Borneo but it was considered unrelated to diseases of the 'penyakit merah' type.

Attention was drawn to the desirability of using leaf injection techniques for the investigation of physiological diseases, and it was mentioned that preliminary work on leaf injection and foliar spraying was being done in Malaya.

The joint meeting of the Working Parties on Rice Breeding and on Fertilizers recommended that the project on physiological diseases in padi be continued as a cooperative one and that interested governments continue with their investigations giving special attention to the following aspects:

1. the effect of reducing conditions in the soil;
2. the influence of the oxygen content of the water;
3. the effect of excess soluble iron in the soil;
4. the effect of application of heavy doses of phosphate;
5. repetition of the experiments reported by Dr. Ponnamperuma, et al;
6. investigations on soil microbiology;
7. growth of algae in wet rice fields;
8. leaf analyses;
9. the relation of Rhadopholus oryzae to physiological diseases.

Progress Report on the Ad Hoc Working Party on Soil-Water-Plant Relationships

The Technical Secretary of the Working Party on Fertilizers reported that in accordance with the recommendation made by the International Rice Commission at its Fourth Session in Tokyo in 1954 an ad hoc Working Group has been established to undertake detailed consideration of soil, water and plant relationships in the production of rice. The Director General of FAO has invited the Governments of seven countries, in which substantial research work on the subject is under way, to each designate a member to the ad hoc Working Group. Five of these Governments accepted the invitation and designated the following members:

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| India | Dr. N. Parthasarathy, Director,<br>Central Rice Research Institute, Cuttack |
| Italy | Professor A. Crocioni, Director,<br>Instituto di Agronomia Generale e Coltivazioni Erbacee<br>Universita di Torino, Torino |
| Japan | Mr. Jisuke Takahashi, Chief<br>Plant Nutrition Section, Chemical Division<br>National Institute of Agricultural Sciences<br>Nishigahara, Kita-ku, Tokyo |
| United Kingdom | Mr. J.K. Coulter, Acting Senior Soil Chemist,<br>Federation of Malaya, Department of Agriculture<br>Kuala Lumpur |
| United States | Mr. L.C. Kapp, Rice Advisor,<br>U.S. Operations Mission to the Philippines<br>Manila |

Mr. Aldert Molenaar, the Technical Secretary of the Working Group, is carrying out by correspondence the task assigned to the Group.

As a first step the members were asked to collect available data and information on the subject within their respective countries and to submit a report giving their analyses of the available data in the light of additional research needs and expressing their views on how the Working Group can most effectively complete its assigned task. Though none of the members has as yet submitted such a report advance notices indicate that some of them will be doing so very soon and it is expected that all of the members will submit their contributions before the end of 1955.

The Working Group fully expects to present a report to the International Rice Commission at its Fifth Session in 1956, setting forth its appraisal of the problems in the field of soil, water and plant relationships and of the kind of further research that will need to be undertaken for the satisfactory solution of these problems.

In 1939 rice cultivation in Western Japan suffered a great loss through drought. The Ministry of Agriculture and Forestry therefore established in 1941 a Prefectural Agricultural Experiment Station for the special task of developing methods of overcoming drought damage in rice cultivation. The Station was established in the Hofu, Yamaguchi Prefecture which is situated on the coast of the inland sea of Western Japan where drought is most likely to occur.

A certain practice called 'delayed irrigation' has been developed. By 'delayed irrigation' is meant withholding water purely (1) during the vegetative stage except for the earliest ten or so days when the rice plants are establishing themselves after transplanting, and (2) again after flooding the fields at the beginning of the panicle formation. Such a procedure increases yields.

The results of experimental work up to date lead to the following conclusions:

1. Draining off all the water has an adverse effect on vegetative growth of the rice plant. Thus the weight of the straw in 'delayed irrigation' is always less than when the rice crop is grown on submerged soils.

2. When rice suffering from water shortage is given ample water at the beginning of the panicle formation, the plants initiate a great many new roots. On the other hand, plants grown on submerged soils show signs of root decay at a time when water is most needed as a result of being kept continually under reductive conditions.

3. Much research has already been done on the role of reductive substances in the decay of roots and therefore no further work is contemplated.

4. Chemical analysis shows that the suppression of the vegetative growth leads to a greater amount of nutrients available for the reproductive stage.

5. The redox potential of padi soils under 'delayed irrigation' is always high which is beneficial to the rice roots, especially at later stages of growth.

6. Experiments have shown that late transplanting cannot replace 'delayed irrigation'.

7. 'Delayed irrigation' is most effective with moderate dressings of fertiliser.

8. It is believed that 'delayed irrigation' is only applicable to South Japan. In the North, the growing period is too short and the delay of growth in the earlier stages would not be overcome. However, flooding throughout the whole growing period is not healthy for the rice roots. The best farmers, who can obtain as much as 9,000 kilogrammes of brown rice per hectare, follow a practice called 'middle drying'. By this is meant the discontinuance of the water supply in the 'middle stage' of plant development.

9. There seems to be a possibility of obtaining greater yields with the consumption of much less water through the practices of 'delayed irrigation' and 'middle drying'.

In French Upper Guinea along the Upper Niger there is an interesting demonstration of the length of maturation period of rice varieties in relation to depth of water and location in a valley or basin. The natural basins present a range of water depths which are correlated with the type and maturation period of the varieties grown. At the bottom of the basins occur the Indo-China floating varietal types maturing in seven and a half months. The milled grain yield of these types as well as the percentage of red grains increases markedly with decrease of water below 0.6 metres. Higher up the banks of the basins grow the Fossa varietal types resembling the 'bulu' with a maturation period of five months. These varieties grow on moist soil subject to flooding. On the rim of the basins the upland rice varieties Bilim Balam are found with a maturation period of 3-4 months.

Other Technical Discussions

Rice Growing in New South Wales

A publication was presented dealing with the development of the rice industry in New South Wales and giving short accounts of cultural methods, varieties grown, kind and amount of fertilisers used, and the control of weeds, diseases and pests. The delegate pointed out that this publication was under revision.

The Effect of Distance of Planting on Rice Lodging (The Philippines)

Three early maturing rice varieties with strong, medium-strong and weak straw respectively were planted at four different spacings ranging from 10 x 10 to 40 x 40 cm. to observe the effect of the distance between plants on the straw character. While the variety with strong straw (Milfor 6) did not lodge at all regardless of the spacing, the other two varieties lodged badly particularly with closer spacing. The degree of lodging in general increased inversely with the distance between rows. While the lodging resistant variety yielded better with close spacing, the optimum spacing for the other varieties was somewhat greater. The variety and treatment interaction was statistically significant. The best distance in relation to yield appears to be either 20 x 20 or 10 x 10 cm.

Suggested Procedures in Conducting Lowland Rice Trials (The Philippines)

This paper describes the procedures adopted in the conduct of rice variety trials in The Philippines. Details are given as to the raising of nurseries, size, shape and arrangement of plots, distance between seedlings at transplanting, use of fertilizers and control of pests. Clear instructions are given on recording times of maturity, harvesting and threshing as well as on determining the plot yields allowing for the moisture content at the time of harvest. The paper also contains plans illustrating the layout of plots.

The use of Herbicides for the Control of Weeds in Lowland Rice (The Philippines)

The experiment described is a complete randomised block with two varieties and two concentrations of each of six different chemicals. The chemicals used were 2, 4-D amine; 2, 4-D; 2, 4, 5-T-A mixture; 2, 4, 5-T amine; MCP amine; L.V-4 and Kuron. These were applied in aqueous solution at 3/4 and 1½ lbs. per acre.

Members of the family Cyperaceae constitute the majority of the weeds present in this experiment and they were all readily controlled by all treatments used. The chemicals affected the rice plants by stunting their growth particularly in the seedling stage, the degree of injury varying with the different chemicals. Of the two varieties tried one was more resistant to the herbicides than the other. Although hand weeded plots gave higher yields than treated plots, the cost of weeding was very much higher than the cost of the chemicals. It was found that 2, 4, 5-T at 1½ lbs. per acre and Kuron at 3/4 or 1½ pounds per acre were the most effective.

Herbicides are commonly used on rice fields by farmers in U.S.A. and experiments are in progress there to determine the extent to which they affect the rice plant.

The delegate from France emphasised the great importance of weed control in upland rice and suggested that investigations on herbicides should include their trial in upland fields.

Rice Variety Trials in Malaya

There are two publications of the Department of Agriculture in Malaya dealing with rice variety trials for the periods 1947-50 and 1950-54. They describe in detail the variety trials conducted in Malaya at over 40 stations scattered over different parts of the country. Though these publications are intended primarily for the information of farmers they contain details which may be useful to countries conducting variety trials on a large scale, or proposing to test Malayan varieties.

Preliminary Report on Laboratory Milling and Cooking Tests with Rice (Malaya)

Determination of the milling and cooking qualities of new strains of rice is an important procedure which a breeder has to undertake. This progress report describes preliminary results of milling tests on 187 samples with different size and shape of grain. It is surprising to note that the long grained variety Siam had a better milling quality than the broad grained varieties. This, however, was in part due to the presence of abdominal white in the broad grained varieties which resulted in more breakage.

Cooking tests were made using a special technique evolved locally and the imbibition ratios $\left(=\frac{\text{volume of cooked rice}}{\text{volume of uncooked rice}}\right)$ were derived. Out of 15 samples from the *indica* x *japonica* crosses tested two had the cooking quality of *japonica* rice, one was intermediate and the rest had the cooking quality of the *indica* type.

Nutrition Studies of some Promising Lowland and Upland Varieties of The Philippines

This investigation was undertaken primarily to determine the variation in the protein and constituent amino-acid contents of 13 varieties. The protein content was found to vary only from 8.19 to 10.90 on dry matter basis, indicating that breeding for high protein content in rice may not be effective.

It was mentioned in the discussion that the range of protein content given in this paper is much narrower than has been recorded in similar investigations elsewhere, e.g. India. Even if a programme of breeding for higher protein content should appear possible it was felt that it may not have any practical value for the reason that with existing methods of milling, polishing and cooking rice, practically the whole protein and amino-acid contents are lost. In addition to losses in milling and polishing there is also further loss in the washing of rice before cooking and in the excess water thrown away after cooking. It was however stressed that a programme of breeding rices with higher protein and amino-acid contents should be worthwhile as even small differences in diets consisting almost entirely of rice might be of value.

In connection with the milling and cooking tests in which all breeders are interested various techniques have been developed and adopted at different research centres. In this connection the Working Party recommended that details of the different techniques followed in different research laboratories be collected and made available for consideration at the next meeting of the Working Party.

Dormancy and Viability of Rice Seed (Malaya)

The period of seed dormancy in Malaya is short in comparison with other tropical countries such as India and Ceylon. The dormancy period of freshly harvested rice in Malaya is shown to be from 5 - 11 weeks only; maximum germination being reached in 5 to 7 weeks after harvest with some varieties. Where offseason cropping is more extensively practised this becomes an important factor. It is of further importance in Malaya in the case of very early maturing rices which may have to be stored for a long period without loss of seed viability. Storage of seed in an air conditioned room shows that the seed can retain its viability up to 3½ years, and this storage system also increases the dormant period. At ordinary temperatures seed stored in a dry atmosphere in air-tight seed containers retains viability up to 2 years.

The Problem of Photoperiod in Low Altitudes.
The Photosensitivity of Rice Variety, Siam 29 (Malaya)

In Malaya the maximum day-length variation in the north is 37 minutes and in the south 9 minutes. The small monthly variations in photoperiod are, however, of considerable importance in the growing of common Malayan varieties.

The first paper gives the results of changes in maturation period when sown at intervals of a month for all 12 months. The experiment included 5 varieties, one non-sensitive, 2 medium sensitive and 2 highly sensitive. When highly sensitive varieties are sown early the months following the sowing date have an increasing day length, and the maturation period is at a maximum, but when these varieties are sown late the following months have a decreasing day length and the maturation period is at a minimum. The period of photosensitivity is limited to the period of growth after the age of 4 weeks and before formation of the flower, and during this sensitive stage only a day-length less than the critical day-length will affect the plant. However, the critical day-length and the length of the non-sensitive period may differ with varieties.

The second paper deals with an experiment with Siam 29, a highly sensitive variety which was subject to long days, over 12 hours, and short days, less than 12 hours. Experimental treatment with long days showed that during the first four weeks of growth the plant is not photosensitive and each subsequent increase of two weeks in light days gives a constant increase in time to flowering.

Further Studies on the Photoperiod Response of Elon-Elon Rice
(The Philippines)

This paper describes interesting results obtained by hot and cold treatments in combination with different photoperiods. The results suggest that low temperature reduced the number of short days necessary for flower initiation but did not seem to hasten flower development. Apparently low temperature with long day treatment could induce flowering. This, however, needs further study. The response to light takes place in the leaves, the most sensitive of which is the youngest unfurled leaf. It is demonstrated that the photoperiod stimulus is non-transferable from one tiller to another.

Irradiation of Rice (Thailand)

This is a short note referring to seed of two Thailand varieties subjected to different degrees of two treatments, X-ray and thermal neutrons. The treated seed does appear to have been affected as is seen by the growth and habit of the seedlings. In most cases treatment with higher doses has somewhat lowered germination and the growth of the plant has also been affected.

Japonica Type Rice in the Sub-Continent of India and Java (Japan)

This is an extremely valuable paper dealing with the results of crosses made between japonica rices and the 'aus' and 'aman' varieties of Pakistan. The 'aus' x japonica crosses show comparatively less sterility as was also the case with 'bulu' x japonica crosses. It is concluded that the 'aus' rice of Pakistan might be a differentiation of indica which may have given rise to japonica types later. This allows the postulation of two differentiating centres of origin, one in the north east of the Indian sub-continent and another in Java on the equator. The Japanese rices now grown in temperate zones may be traced back genealogically to the 'aus' type of rice in tropical Asia.

While the hypothesis propounded may be an interesting one it needs more data to confirm it. The absence of sterility in crosses between 'aman' and 'aus' and the high sterility in crosses between 'aman' and japonica require explanation.

Insecticidal Control of the Green Padi Bug (Leptocorisa acuta) (Malaya)

The attack by this pest is most severe where certain wild grasses are abundant near the fields and especially where there are adjacent areas of secondary jungle. In such areas the bugs shelter and breed during the off-season. The use of a "Swingfog" machine loaded with one part of 25% DDT in oil to 3 parts of Sovacide PYF or 15% emulsified concentrate of Dieldrin at one part of insecticide to 5 parts of water were found effective in control.

Some Experiments on the Insecticidal Control of the Rice Stem Borers in The Philippines.

There were distinct varietal differences in the susceptibility to stem borers and consequently in yields. Varieties Biang, Fortuna and Milfor appeared most susceptible. The comparison of different spraying schedules showed increased control by more frequent applications, and early applications showed the least control. Three applications at 1, 2 and 3 months after transplanting gave the greatest benefit. Comparison of various insecticides indicated that Endrin was consistently effective at $\frac{1}{2}$ - 1 pound of 15% emulsifiable concentrate per acre. Emulsifiable Parathion was erratic in its effect. EPN wettable powder was generally effective whereas Toxaphene was effective only at higher dosages. In one experiment with Diazinone the stem borer control was not as effective as with Endrin. In the test on different methods of application the low gallonage spray appeared to be best. The effect of spraying on borer infestation was very evident.

Studies on Sheath Spot Disease of Rice (The Philippines)

The paper deals with the sheath spot caused by Rhizoctonia solani common in the Philippines. While generally the disease is of minor importance, in warm moist weather it can cause considerable spotting resulting in stunting of the plants, arrested emergence of the panicle and sterility of the grains. The pathogen attacks rice plants at all stages of development. In cross inoculation experiments this rice fungus was transferable to pepper, tomato, eggplant, string bean, peanut and soya bean. Even species of grasses are found to be natural hosts. Out of 14 parent rice varieties tested two showed fair resistance to the disease. The disease may be controlled by phyto-sanitary measures, improved agricultural practices and use of fungicides.

## SUMMARY OF RECOMMENDATIONS

In addition to the numerous suggestions included in the body of the report, the Working Party on Rice Breeding, at its Sixth Meeting, made the following recommendations:-

1. On the completion of the International Rice Hybridization Project, each member country should include in its report to the Working Party a statement on the progress made with the International Rice Hybridization Project hybrids in their national rice breeding programme.

2. FAO should organize a further training centre for rice breeders by 1957 on similar lines to the previous ones, and consideration should be given both to locating it in a new area and to the offer from Japan to provide facilities.

3. Copies of the lectures delivered at previous and future training centres on rice breeding should be reproduced and circulated to all member countries.

4. The attempt to determine a simple method of selection for lodging resistance for general application by coordinated experiments should be discontinued, but in view of the growing interest in the subject, countries should continue and expand the investigations they have in progress; countries which have already commenced or propose commencing the coordinated experiment during the current season should do so and should forward the results to the coordinator as hitherto; after the current season the subject should be periodically reviewed as data accumulated and an item included in the Working Party's agenda from time to time for this purpose.

5. When the ad hoc Working Party on Rice Soil-Water-Plant Relationships has presented its report at the 1956 meeting, consideration should be given to the initiation of research on this subject by member countries on a cooperative basis.

6. Work on physiological diseases of rice should be continued as a cooperative project and interested countries should continue their investigations giving special attention to the effect of reducing conditions in the soil, the influence of the oxygen content of the water, the effect of excess iron in the soil, the effect of application of heavy dosages of phosphate, the work reported by Dr. Ponnamperuma, investigations on soil microbiology, the growth of algae in wet rice fields, leaf analyses and Rhadopholus oryzae in relation to physiological diseases.

7. Member countries should continue cooperative investigations on the interaction of fertilizer response with varieties. It is further recommended that, where such an interaction has already

been clearly demonstrated, consideration should be given to separating the effects of the different nutrient elements by suitable investigations, and that the time of application of each of these nutrients should be studied in relation to their effect on this interaction. At a later stage in these investigations, a study might be made of the gradient of the response curves of different varieties as suggested by the coordinator.

8. All countries working on the biological control of rice pests should continue to do so actively and that all available information should be sent to FAO in Rome with a request that a consolidated report be prepared for consideration and necessary action at the next meeting.

9. At the proposed station for research on biological control of pests to be established in India, early attention should be given to parasitical control of rice stem borers in view of the great economic importance of this crop and the serious losses brought about by these pests.

10. Member countries should, wherever facilities exist, intensify their work on breeding new varieties resistant to blast disease; genetic stocks maintained at the four centres, with the exception of Indonesia where blast disease does not occur, should be tested for susceptibility to blast in order to isolate resistant varieties; the Director of the Central Rice Research Institute, Cuttack should prepare for distribution a list of all the resistant varieties available; in view of the possible physiological specialization of the pathogen, all resistant varieties, wherever growing, should be tested in all countries where blast occurs, and full information of the conditions under which they are grown in the country of origin should be furnished.

11. FAO should suggest to member countries the inclusion of mycologists and entomologists in their delegations to the next meeting in order to ensure a fuller discussion of the estimation of losses due to pests and diseases of rice in the light of information available from Japan, India, Malaya and elsewhere, and the possibilities of cooperative action should then be considered.

12. In view of handicaps experienced by rice breeders on account of insufficient knowledge on the genetics of rice, member countries should make provision for the intensification of studies on rice genetics by providing facilities and by training personnel for the purpose; as a first step towards encouraging linkage studies, FAO should organize a small committee to examine the present position of linkage in rice, to resolve difficulties of nomenclature, and report at the next meeting.

13. In view of the importance of the evaluation of quality in rice and the growing interest in this subject, FAO should collect information on milling and cooking quality and on techniques applicable to rice for presentation at the next meeting.

PAPERS PRESENTED TO THE MEETING

Australia

Rice Growing in New South Wales. Department of Agriculture

Burma

Progress Report on Growing of IRC Hybrid Paddies (Indica x Japonica) at Mandalay, Burma, under Irrigated Conditions, for the year 1954-55.

Progress Report on the Japonica-Indica Rice Hybridization Project in Lower Burma.

Egypt

Progress in Rice Breeding in Egypt in 1954. M.A. Koshiary, C.L. Pan and Others. Ministry of Agriculture.

France

Travail de Sélection du Riz en 1954 dans les Territoires Africains de l'Union Française. Le Service Riz, Cultures Vivrières de l'Office de la Récherche Scientifique et Technique Outre-Mer.

Etat Actuel et Perspective des Recherches Concernant les Series Variétales en Riziculture de Haute-Guinée. M. Degras, Division de Phytotechnie de la Station Rizicole de Kankan.

Obtention de Nouvelles Variétés de Riz et Production des Semences à la Station Agricole de Marovoay, Madagascar. M. Doblemann, Station Rizicole de Marovoay.

Quelques Hymenopteres du Nord Cameroun Parasites d'Insectes Nuisibles au Riz, M. Descamps, Bureau Antiacridien et de la Base phytosanitaire.

India

Report on the Progress of Rice Breeding in India in 1954

Report of the FAO International Rice Hybridization Project for the period June 1954 to October 1955.

Summary Report of the Cytologist - International Rice Hybridization Project.

Report of the Supervisor (Director, Central Rice Research Institute, Cuttack) on the Maintenance of Genetic Stocks.

Report on the Second International Training Centre on Rice Breeding, Central Rice Research Institute, Cuttack.

Effect of Lodging on Yield. M. Subbiah Pillai, Central Rice Research Institute, Cuttack.

India (cont.)

Biological Control of Rice Pests. P. Israel, Central Rice Research Institute, Cuttack.

Methods of Testing Rice Varieties to Blast and Progress made in Breeding Resistant Varieties, Central Rice Research Institute, Cuttack.

Estimation of Losses due to Pests of Rice. P. Israel and G. Veda Moorthy, Central Rice Research Institute, Cuttack.

Methods of Testing Rice Varieties to Blast and Progress made in Breeding Resistant Varieties, Central Rice Research Institute, Cuttack.

Estimation of Loss caused by Blast Diseases of Rice. S.Y. Padmanabhan and D. Ganguly.

Indonesia

The International Rice Hybridization Project.

Report on Progress in Rice Breeding in Indonesia.

Japan

Correlation Between Physical Character of Rice Plant Culms and Lodging of Rice Plants. N. Yamada and J. Iyama, National Institute of Agricultural Science.

Experiments on Lodging of Paddy Rice Plants. H. Seko and Others, Tokai-Inki Agricultural Experiment Station.

Rice Breeding for High Yielding Varieties in Japan. Takane Matsuo

Abstracts of Studies on the Inheritance of Yield Components of Rice Plants.

Japonica Type Rice in the Subcontinent of India and Java. T. Morinaga and H. Kuriyama.

Some Aspects of Rice Breeding for Blast Resistance in Japan. Chikashi Shigemura.

Linkage Studies in Rice.

A Short Review on the Recent Works on the Estimation of Loss of Rice Crops by Insect Pests in Japan. Hidetsugu Ishikura.

Korea

The Progress of Rice Breeding and the Development of Rice Varieties in Korea. Y.S. Chang.

Netherlands

Rice Breeding in Surinam.

Pakistan

Report on the Rice Hybridization Project 1953-54

A Short Report on Crops raised from Indica x Japonica $F_2$ Seeds received from Cuttack in April 1955.

Report of the Rice Hybridization Project of FAO 1954-55

Maintenance of Genetic Stock of Floating Rice at Habiganj.

Resistance to Lodging.

Physiological Disease of Rice in East Pakistan.

Yield Response of Japonica and Indica Varieties of Rice to Increasing Supply of Nitrogen in East.

Philippines

Further Studies on the Photoperiodic Response of Elon-Elon Rice. J.R. Velasco and F.C. Manuel.

Studies on Sheath Spot Disease of Rice. F.T. Orillo and R.B. Velez.

The Effect of Distance of Planting on Rice Lodging. D.L. Umali and Others.

Some Experiments on the Insecticidal Control of the Rice Stem Borers in The Philippines. G.B. Viado and J.G. Matthysse.

The Effect of Time of Lodging upon the Yield and other Agronomic Characters of Rice. D.L. Umali and Others.

Nutritive Studies of some Promising Lowland and Upland Varieties of the Philippines. Apolinario R. Caradgal Jr. and Elvira Manzanilla

Suggested Procedures in conducting Lowland Rice Trials. D.L. Umali.

Effect of Continuous and Discontinuous Submergence on Rice Lodging and Yield. A.P. Aglibut and P.R. Hoff.

The Use of Herbicides for the Control of Weeds in Lowland Rice. Marcos R. Vega and S.N. Fertig.

Usefulness of Early-Maturing Lowland Rice Varieties. D.L. Umali and J.N. Tenora.

Rice Improvement in the Philippines during the Year ending June 30th 1955. Juan P. Torres, Bureau of Plant Industry.

Thailand

Some Preliminary Studies of Rice Straws. Sala Dasananda.

Report on the Japonica-Indica Hybrids in Thailand. Krui Punyasingh.

Irradiation of Rice. J.K. Middleton and Krui Punyasingh

Progress Report of Rice Breeding in Thailand. Sala Dasananda and H.H. Love.

United Kingdom - Federation of Malaya

Rice Improvement in Malaya in 1954-55. F.B. Brown, Department of Agriculture.

Insecticidal Control of the Green Padi Bug. R.J.A.W. Lever, Department of Agriculture.

Preliminary Report on Laboratory Milling and Cooking Tests with Rice. Van Thean Kee, Department of Agriculture.

Photoperiodism in Malaya. The Problem of Photoperiod in Low Latitudes. J. Dore, Department of Agriculture.

On the Photosensitivity of the Rice Variety Siam 29. J. Dore, Department of Agriculture

Dormancy and Viability of Padi Seed. J. Dore, Department of Agriculture.

Rice Variety Trials in Malaya 1947-50. L.N.H. Larter, Department of Agriculture

Rice Variety Trials in Malaya 1950-54. L.N.H. Larter, Department of Agriculture

IRC International Hybridization Scheme. Indica x Japonica Hybrids in Malaya. F.B. Brown.

Breeding for Lodging Resistance in Rice. L.N.H. Larter.

Possibilities of Biological Control of Rice Insects in South East Asia. R.J.A.W. Lever, Department of Agriculture.

Rearing and Liberation of Parasites of Padi Stem-Borers in Malaya. R.J.A.W. Lever, Department of Agriculture.

Rice Blast (Piricularia oryzae Cav.) in Malaya. A. Johnston, Department of Agriculture.

Estimation of Crop Losses in Padi in Malaya due to Insects. R.J.A.W. Lever, Department of Agriculture.

Padi Stem-Borer Investigations in Krian, Perak. I.J. Wyatt, Department of Agriculture.

Lodging Resistance in Rice. J. Dore, Department of Agriculture.

United States of America

Changes in Rice Varieties in the United States from 1931 to 1954. C. Roy Adair, U.S. Department of Agriculture.

Viet-Nam

Report on Rice Breeding and Multiplication in Viet-Nam in 1954-55.

FAO

Cooperative Variety Trials.

World Catalogue of Genetic Stocks - Rice - Supplement No.5.

## TIME AND PLACE OF THE NEXT MEETING

The Working Party on Rice Breeding decided to recommend the acceptance of the generous offer of the Government of India and to hold its seventh meeting together with the sixth meeting of the Working Party on Fertilizers in India. These meetings will probably commence in October, 1956, immediately prior to the meeting of the International Rice Commission; the exact time and place will be announced later.